US009430939B2

(12) **United States Patent**
Shearer et al.

(10) **Patent No.: US 9,430,939 B2**
(45) **Date of Patent: Aug. 30, 2016**

(54) **SYSTEM AND METHOD FOR PROVIDING AN IN-VEHICLE TRANSMITTER HAVING MULTI-COLORED LED**

(71) Applicant: **Gentex Corporation**, Zeeland, MI (US)

(72) Inventors: **Carl Shearer**, Hudsonville, MI (US); **William M. Jarocha**, South Lyon, MI (US); **Jeremy Bos**, Wailuku, HI (US); **Todd R. Witkowski**, Zeeland, MI (US)

(73) Assignee: **GENTEX CORPORATION**, Zeeland, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/020,641**

(22) Filed: **Sep. 6, 2013**

(65) **Prior Publication Data**

US 2014/0009263 A1 Jan. 9, 2014

Related U.S. Application Data

(63) Continuation of application No. 11/443,513, filed on May 30, 2006, now Pat. No. 8,531,266, which is a continuation-in-part of application No. 10/531,667, filed as application No. PCT/US03/33252 on Oct. 20, 2003, now abandoned.

(60) Provisional application No. 60/419,451, filed on Oct. 18, 2002.

(51) **Int. Cl.**

G08C 17/02	(2006.01)
G05B 19/042	(2006.01)
G08C 23/04	(2006.01)

(52) **U.S. Cl.**

CPC ***G08C 17/02*** (2013.01); ***G05B 19/0426*** (2013.01); ***G08C 23/04*** (2013.01); *G05B 2219/23297* (2013.01); *G08C 2201/50* (2013.01)

(58) **Field of Classification Search**

CPC G07C 9/00309; G07C 2009/00793; G07C 2209/63; G07C 9/00111; B60R 25/24; G08C 17/02; G08C 23/04; G05B 19/0426

USPC 34/4.3, 815.45, 815.4, 815.53, 13.31, 34/3.7, 12.54; 340/4.3, 815.45, 815.4, 340/815.53, 13.31, 3.7, 12.54, 5.1, 5.61, 340/5.62, 5.64, 5.32, 5.25

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,846,467 A	7/1989	Rosson
5,210,532 A	5/1993	Knoedler et al.

(Continued)

FOREIGN PATENT DOCUMENTS

DE	43 02 015 A1	8/1993
EP	1 014 326 A1	6/2000

(Continued)

OTHER PUBLICATIONS

European Office Action dated Jun. 8, 2012 as received in corresponding European Application No. 07 797 852.6, 6 pages.

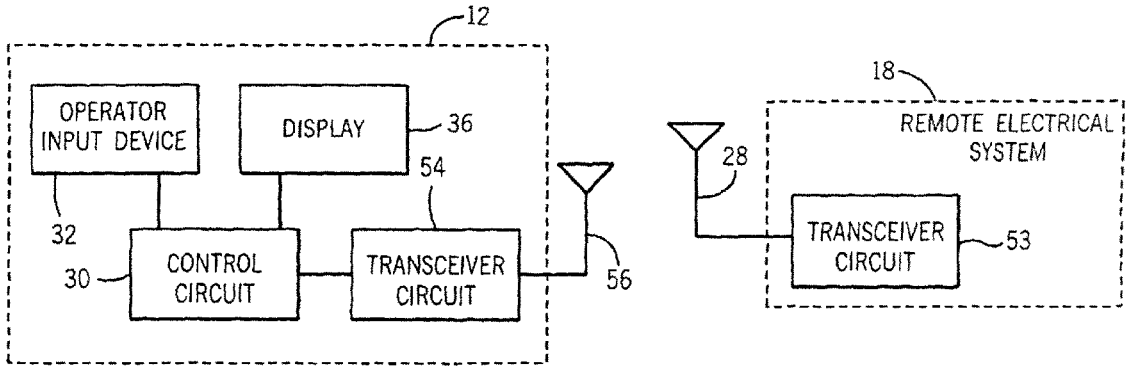
(Continued)

Primary Examiner — Jennifer Mehmood
Assistant Examiner — Yong Hang Jiang
(74) *Attorney, Agent, or Firm* — Foley & Lardner LLP; Scott P. Ryan

(57) **ABSTRACT**

A wireless control system for wireless control of a remote electronic system is configured to provide information to a user using a multi-colored LED. The system includes a transmitter circuit configured to transmit a wireless control signal having control data which will control the remote electronic system, a multi-colored light emitting diode display configured to provide an indication of a state of the wireless control system, and a control circuit coupled to the trainable transmitter circuit configured to transmit the wireless control signal through the trainable transmitter circuit based on the state of the wireless control system.

17 Claims, 5 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,726,645	A	3/1998	Kamon et al.	
5,761,206	A	6/1998	Kackman	
5,896,575	A	4/1999	Higginbotham et al.	
5,905,433	A	5/1999	Wortham	
5,973,611	A	10/1999	Kulha et al.	
6,028,537	A	2/2000	Suman et al.	
6,091,343	A *	7/2000	Dykema et al.	340/13.21
6,271,765	B1 *	8/2001	King	G01C 21/26 340/10.1
6,426,820	B1	7/2002	Verzulli	
6,433,699	B1	8/2002	Slomowitz et al.	
6,466,832	B1	10/2002	Zuqert et al.	
6,490,439	B1	12/2002	Croft et al.	
6,513,723	B1 *	2/2003	Mueller et al.	236/46 R
6,970,082	B2	11/2005	Reese et al.	
6,980,117	B1	12/2005	Kirkland et al.	
7,102,513	B1 *	9/2006	Taskin et al.	340/540
7,257,426	B1	8/2007	Witkowski et al.	
7,346,374	B2	3/2008	Witkowski et al.	
7,349,722	B2	3/2008	Witkowski et al.	
2002/0180600	A1	12/2002	Kirkland et al.	
2002/0190872	A1	12/2002	Suman et al.	
2002/0197955	A1	12/2002	Witkowski et al.	
2003/0197594	A1	10/2003	Olson et al.	
2003/0197595	A1	10/2003	Olson et al.	
2003/0228829	A1	12/2003	Falk	
2003/0228879	A1	12/2003	Witkowski et al.	
2004/0048622	A1	3/2004	Witkowski et al.	
2004/0110472	A1	6/2004	Witkowski et al.	
2005/0088315	A1 *	4/2005	Klein et al.	340/825.69
2005/0090279	A9	4/2005	Witkowski et al.	
2006/0158344	A1	7/2006	Bambini et al.	
2007/0008065	A1	1/2007	Shearer et al.	

FOREIGN PATENT DOCUMENTS

JP	10-176448		6/1998
JP	10-191464		7/1998
JP	2001-012176		1/2001
KR	20040058656		7/2004
WO	WO-00/75905	A1	12/2000
WO	WO-2004/036526	A2	4/2004

OTHER PUBLICATIONS

International Search Report and Written Opinion dated Jan. 21, 2008 as received in International Application No. PCT/US2007/069902, 9 pages.

International Search Report dated Apr. 6, 2004 as received in International Application No. PCT/US2003/033252, 4 pages.

Office Action dated Feb. 9, 2009 as received in U.S. Appl. No. 10/531,667, 10 pages.

Office Action dated Feb. 10, 2011 as received in U.S. Appl. No. 11/443,513, 16 pages.

Office Action dated Jul. 26, 2010 as received in U.S. Appl. No. 11/443,513, 11 pages.

Priority Document for U.S. Appl. No. 60/419,451, dated Jan. 7, 2004, 23 pages.

Office Action dated Nov. 10, 2009 as received in U.S. Appl. No. 10/531,667, 16 pages.

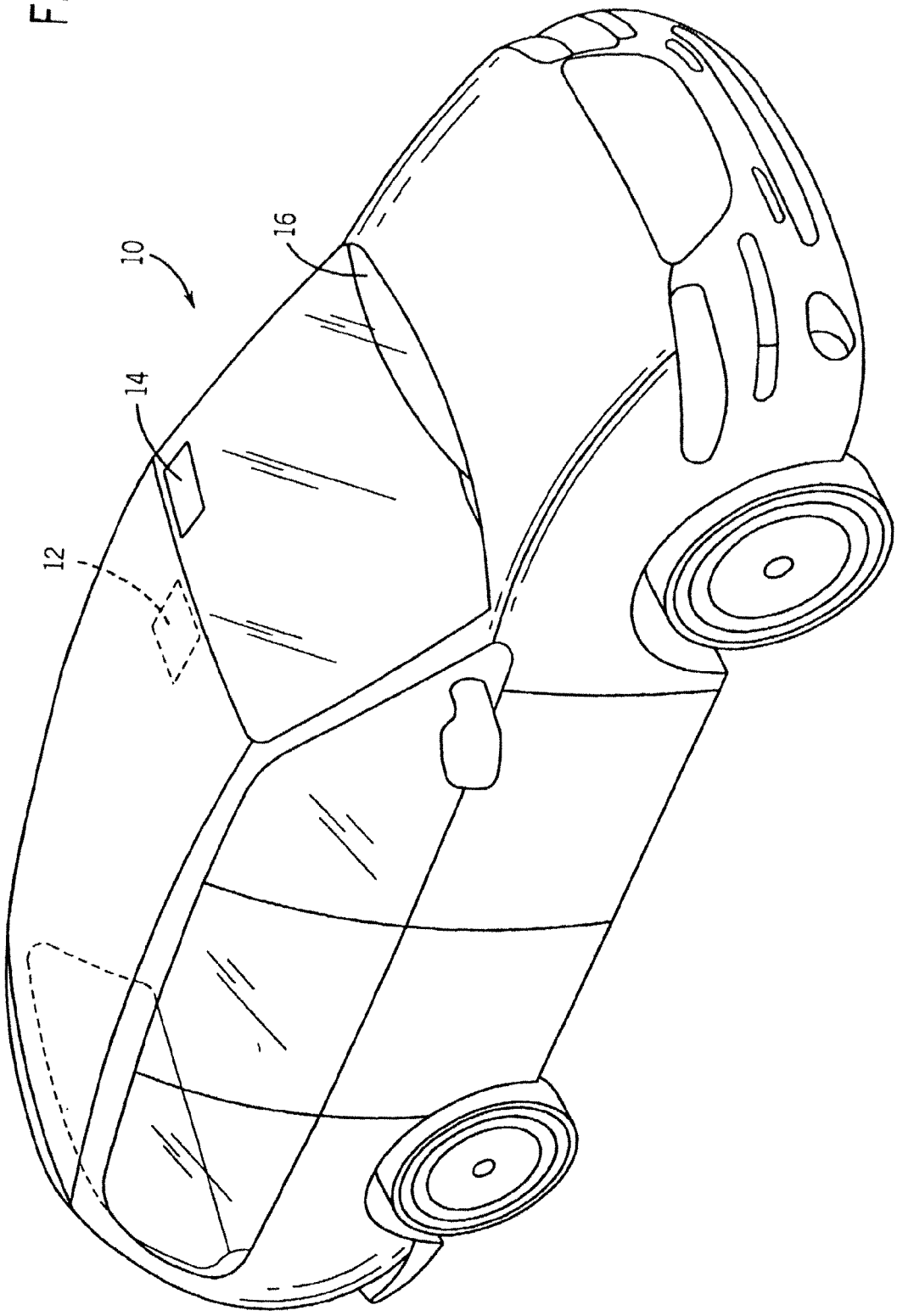
Office Action dated Mar. 25, 201 1 as received in U.S. Appl. No. 10/531,667.

Office Action dated Sep. 29, 2011 as received in U.S. Appl. No. 11/443,513.

Office Action dated Nov. 16, 2015, received in corresponding European application No. 07 797 852.6, 5 pages.

* cited by examiner

FIG. 1



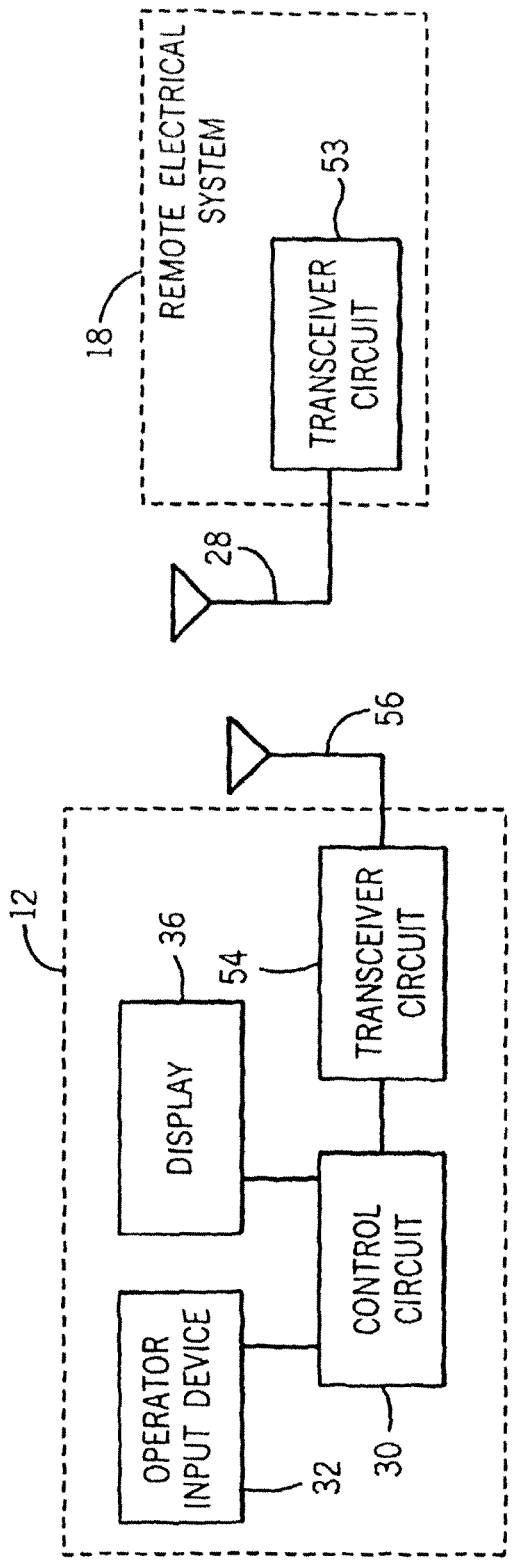

REMOTE ELECTRICAL SYSTEM
18
TRANSCEIVER CIRCUIT
53
28
56
12
DISPLAY
36
54
TRANSCEIVER CIRCUIT
OPERATOR INPUT DEVICE
32
CONTROL CIRCUIT
30

FIG. 2

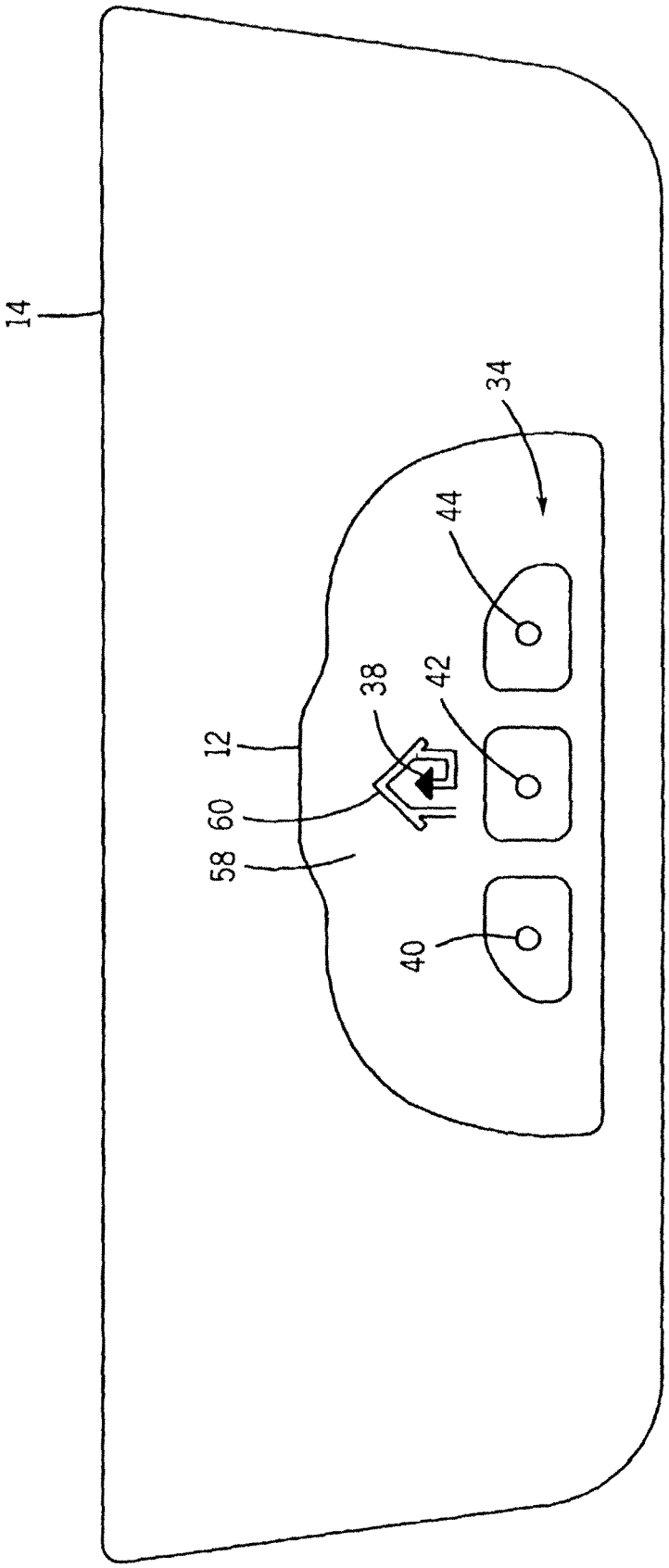


FIG. 3

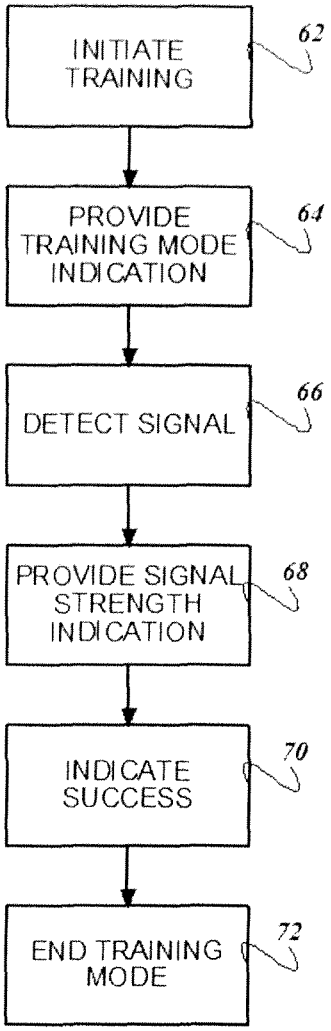

INITIATE TRAINING
62
PROVIDE TRAINING MODE INDICATION
64
DETECT SIGNAL
66
PROVIDE SIGNAL STRENGTH INDICATION
68
INDICATE SUCCESS
70
END TRAINING MODE
72

Fig. 4

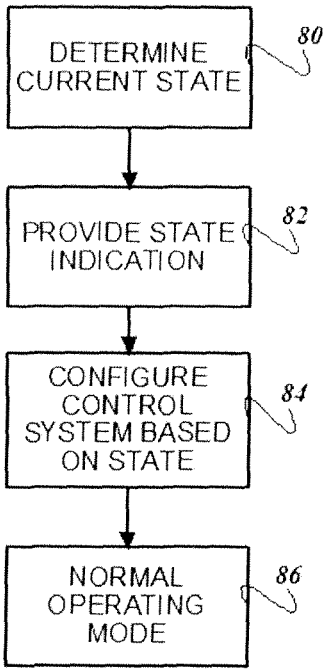

DETERMINE CURRENT STATE
80
PROVIDE STATE INDICATION
82
CONFIGURE CONTROL SYSTEM BASED ON STATE
84
NORMAL OPERATING MODE
86

Fig. 5

SYSTEM AND METHOD FOR PROVIDING AN IN-VEHICLE TRANSMITTER HAVING MULTI-COLORED LED

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 11/443,513, entitled "System and method for providing an in-vehicle transmitter having multi-colored led," filed May 30, 2006, which is a continuation-in-part of U.S. patent application Ser. No. 10/531,667, entitled "System and method for receiving a wireless status signal in a vehicle from a remote electronic system," filed Oct. 20, 2003,which is a National Stage of International Application No. PCT/US2003/033252,entitled "System and method for receiving a wireless status signal in a vehicle from a remote electronic system," filed Oct. 20, 2003,which claims priority to U.S. Provisional Patent Application No. 60/419,451, entitled "System and method for receiving a wireless status signal in a vehicle from a remote electronic system," filed Oct. 18, 2002, the entire disclosures of all of which are incorporated herein by reference.

BACKGROUND

In the field of wireless control of remote electronic systems, technological advances have been developed to improve convenience, security, and functionality for the user. One example is a trainable transceiver for use with various remote electronic systems, such as security gates, garage door openers, lights, and security systems. A user trains the trainable transceiver by, for example, transmitting a signal from a remote controller in the vicinity of the trainable transceiver. The trainable transceiver learns the carrier frequency and data code of the signal and stores this code for later retransmission. In this manner, the trainable transceiver can be conveniently mounted within a vehicle interior element (e.g., visor, instrument panel, overhead console, etc.) and can be configured to operate one or more remote electronic systems.

The success of the training operation for the trainable transceiver is dependent in part upon receiving a quality signal from the remote controller. However, a user may not be able to tell whether a quality signal was received until the trainable transmitter attempts to transmit the learned signal and the operation is a success or failure. Additionally, the success or failure of the transmission may have occurred based on signal strength, but may also have been caused by interference, a failure of the remote device, etc.

Other advances are also needed in the field of wireless control of remote electronic systems, particularly in the case of using automotive electronics to control remote electronic systems. As automotive manufacturers are adding an increased number of electronic systems to the vehicle to improve convenience, comfort, and productivity, simplifying the interface and control of these electronic systems is also becoming increasingly important. In addition, as automotive manufacturers are adding increased electronic systems to the vehicle, providing greater and more refined control over more systems is also becoming increasingly important.

The operator of a trainable transmitter often will use the trainable transmitter to control a large number of remote electronic systems at a variety of locations. For example, the operator may use the trainable transmitter to control a first set of remote electronic systems at his home, such as an entry gate, a garage door opener, and a home security system and to control a second set of remote electronic systems at an office location, such as a parking garage lift gate and a building entry door. Control of the large number of systems is difficult because of the number of control switches that may be required and the limited space available in the driver area of a vehicle.

What is needed is an improved wireless control system and method for wireless control of a remote electronic system from a vehicle, wherein the trainable transmitter is configured to provide information using a multi-colored LED. Further, what is needed is a system and method of using a multi-colored LED to allow a trainable transmitter to control a large number of remote electronic systems using a simple interface. Further still, what is needed is a trainable transmitter configured to provide an indication of the signal strength being received at the trainable transmitter from a remote control.

The teachings herein below extend to those embodiments which fall within the scope of the appended claims, regardless of whether they accomplish one or more of the above-mentioned needs.

SUMMARY

According to an exemplary embodiment, a wireless control system for wireless control of a remote electronic system configured to provide information to a user using a multi-colored LED is provided. The system includes a transmitter circuit configured to transmit a wireless control signal having control data which will control the remote electronic system, a multi-colored light emitting diode display configured to provide an indication of a state of the wireless control system, and a control circuit coupled to the trainable transmitter circuit configured to transmit the wireless control signal through the trainable transmitter circuit based on the state of the wireless control system.

According to another exemplary embodiment, a wireless control system for wireless control of a remote electronic system configured to provide information to a user using a multi-colored LED is described. The system includes a trainable transmitter circuit configured to transmit a wireless control signal having control data which will control the remote electronic system, a multi-colored light emitting diode display configured to provide feedback indicative of received signal strength during a training mode, and a control circuit coupled to the trainable transmitter circuit configured to transmit the wireless control signal through the trainable transmitter circuit based on the state of the wireless control system.

According to yet another exemplary embodiment, a method of providing training mode feedback to a user of a wireless control system for wireless control of a remote electronic system in a training mode is provided. The method includes receiving a wireless control signal, determining the signal strength of the received wireless control signal, and modifying the color of a multi-colored light emitting diode based on the signal strength of the received wireless control signal.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will become more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, and in which:

FIG. **1** is a perspective view of a vehicle having a wireless control system, according to an exemplary embodiment;

FIG. **2** is a block diagram of a wireless control system and a remote electronic system, according to an exemplary embodiment;

FIG. **3** is a schematic diagram of a visor having a wireless control system mounted thereto, according to an exemplary embodiment;

FIG. **4** is a flowchart illustrating a method of improving training for the wireless control system for FIG. **2** by providing an indication of the strength of a signal being received from an original transmitter using a multi-colored LED, according to an exemplary embodiment; and

FIG. **5** is a flowchart illustrating a method of providing state information for the wireless control system of FIG. **2** using a multi-colored LED, according to an exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Referring first to FIG. **1**, a vehicle **10**, which may be an automobile, truck, sport utility vehicle (SUV), mini-van, or other vehicle, includes a wireless control system **12**. Wireless control system **12**, the exemplary embodiments of which will be described herein below, is illustrated mounted to an overhead console of vehicle **10**. Alternatively, one or more of the elements of wireless control system **12** may be mounted to other vehicle interior elements, such as a visor **14** or instrument panel **16**. Alternatively, wireless control system **12** could be mounted to a key chain, keyfob or other handheld device.

Referring now to FIG. **2**, wireless control system **12** is illustrated along with a remote electronic system **18** which may be any of a plurality of remote electronic systems, such as, a garage door opener, a security gate control system, security lights, remote lighting fixtures or appliances, a home security system, etc. For example, remote electronic system **18** may be a garage door opener, such as the Whisper Drive garage door opener, manufactured by the Chamberlain Group, Inc., Elmhurst, Ill. Remote electronic system **18** may also be a lighting control system using the X**10** communication standard. Remote electronic system **18** includes a transceiver circuit **53** and an antenna **28**.

Transceiver circuit **53** includes transmit and/or receive circuitry configured to communicate via antenna **28** with wireless control system **12**. Transceiver circuit **53** is configured to receive wireless control signals having control data which will control remote electronic system **18**. For example, the control data can cause a garage door opener to open or close a garage door. Transceiver circuit **53** may further be configured to transmit wireless status signals having status data indicating the current status of remote electronic system **18**.

The status data on the wireless status signal may include a "SUCCESS" status indicative that the control signal was properly received and the control function was successfully executed by remote electronic system **18**. The wireless status signal may be sent upon completion of the function specified in the wireless control signal. The status data may also be an "ACKNOWLEDGE" status indicative that a proper wireless control signal was received by transceiver circuit **53**. According to an alternative embodiment, remote electronic system **18** can send a plurality of "IN PROCESS" status signals until completion of the operation whereupon a "SUCCESS" or "FAILURE" status signal may be sent. According to yet more alternative embodiments, the wireless status signal may include other information relevant to remote electronic system **18** for transmittal to wireless control system **12**. Examples can include whether a garage door is open or closed or moving between open and closed position, whether a security system is armed or disarmed, whether a light is on or off, etc. The wireless signals are preferably in the ultra-high frequency (UHF) band of the radio frequency spectrum, but may alternatively be infrared signals or other wireless signals.

Wireless control system **12** includes a control circuit **30** configured to control the various portions of system **12**, to store data in memory, to operate preprogrammed functionality, etc. Control circuit **30** may include various types of control circuitry, digital and/or analog, and may include a microprocessor, microcontroller, application-specific integrated circuit (ASIC), or other circuitry configured to perform various input/output, control, analysis, and other functions to be described herein. Control circuit **30** is coupled to an operator input device **32** which includes one or more push button switches **34** (see FIG. **3**), but may alternatively include other user input devices, such as, switches, knobs, dials, a voice-actuated input control circuit configured to receive voice signals from a vehicle occupant, etc. and to provide such signals to control circuit **30** for control of system **12**.

Control circuit **30** is further coupled to a display **36** which includes a light-emitting diode (LED), such as display element **38**. Display **36** may alternatively include other display elements, such as a liquid crystal display (LCD), a vacuum florescent display (VFD), or other display elements. Display element **38** can include a single multi-colored LED (e.g., green, red, and yellow) or multiple LEDs, each representing a different color.

Wireless control system **12** further includes a transceiver circuit **54** including transmit and/or receive circuitry configured to communicate via antenna **56** with remote electronic system **18**. Transceiver circuit **54** is configured to transmit wireless control signals having control data which will control remote electronic system **18**. Transceiver circuit **54** is further configured to receive wireless status signals including status information from remote electronic system **18**.

In operation, wireless control system **12** is configured to receive one or more characteristics of an activation signal sent from an original transmitter. An original transmitter is a transmitter, typically a hand-held transmitter, which is sold with remote electronic system **18** or as an after-market item, and which is configured to transmit an activation signal at a predetermined carrier frequency and having control data configured to actuate remote electronic system **18**. For example, the original transmitter can be a hand-held garage door opener transmitter configured to transmit a garage door opener signal at a frequency, such as 355 megaHertz (MHz), wherein the activation signal has control data, which can be a fixed code or a cryptographically-encoded code. Remote electronic system **18** is configured to open a garage door, for example, in response to receiving the activation signal from the original transmitter.

Transceiver **54** is configured to receive one or more characteristics of the activation signal from the original transmitter or from another source, which characteristics can include the frequency, control data, modulation scheme, etc. In this embodiment, transceiver **54** is configured to learn at least one characteristic of the activation signal by receiving the activation signal, determining the frequency of the activation signal, and demodulating the control data from the activation signal. Wireless control system **12** can be a

Homelink® trainable transceiver, manufactured by Johnson Controls Interiors LLC, Holland, Mich., and may be constructed according to one or more embodiments disclosed in U.S. Pat. Nos. 6,091,343, 5,854,593 or 5,708,415,which are herein incorporated by reference in their entirety. Alternatively, wireless control system **12** can receive one or more characteristics of the activation signal by other methods of learning. For example, the one or more characteristics of the activation signal can be preprogrammed into memory during manufacture of wireless control system **12** or can be input via operator input device **32** (which can include a key pad, buttons, etc.). In this manner, wireless control system **12** need not actually receive the activation signal in order to receive characteristics of the activation signal. Wireless control system **12** can receive the characteristics of the signal by any of these methods and store the characteristics of the activation signal in memory.

Transceiver circuit **54** is configured, under control from control circuit **30**, to generate a carrier frequency at any of a number of frequencies in the ultra-high frequency range, preferably between 20 and 470 megaHertz (MHz), more specifically between 280 and 430 MHz, wherein the control data modulated on to the carrier frequency signal may be frequency shift key (FSK) or amplitude shift key (ASK) modulated, or may use another modulation technique. The control data on the wireless control signal may be a fixed code or a rolling code or other cryptographically encoded control code suitable for use with remote electronic system **18**.

Referring now to FIG. **3**, an exemplary wireless control system **12** is illustrated coupled to a vehicle interior element, namely a visor **14**. Visor **14** is of conventional construction, employing a substantially flat, durable interior surrounded by a cushioned or leather exterior. Wireless control system **12** is mounted to visor **14** by fasteners, such as, snap fasteners, barbs, screws, bosses, etc. and includes a molded plastic body **58** having three push button switches disposed therein. Each of the switches includes a respective back-lit icon **40**, **42**, **44**. According to an exemplary embodiment, back-lit icons **40**, **42**, **44** may be implemented as a multi-colored LED, similar to display **36**. Body **58** further includes a logo **60** inscribed in or printed on body **58** and having a display element **30** disposed therewith, During training and during operation, display element **38** is selectively lit by control circuit **30** (FIG. **2**) to communicate certain information to the user, such as, a current state of the control system **12**, whether the control system **12** is transmitting a wireless control signal, the relative strength of a signal being received by control system **12**, etc. The embodiment shown in FIG. **3** is merely exemplary, and alternative embodiments may take a variety of shapes and sizes, and have a variety of different elements.

In operation, wireless control system **12** is configured for wireless control of remote electronic system **18**. Wireless control system **12** is configured to provide feedback to the user regarding the training of control system **12**, the current state of control system **12**, etc. For example, wireless control system **12** may be configured to use a multi-colored LED display **38** to provide feedback to a user regarding the strength of a signal received from an original transmitter being received at control system **12**, as will now be described with reference to FIG. **4**. According to another example, wireless control system **12** may be configured to use multi-colored LED display **36** to provide an indicia of a current state of wireless control system **12**, where the current state affects the functionality associated with input devices **34**, as will be described below with reference to FIG. **5**

Referring now to FIG. **4**, an exemplary method of improving training for wireless control system **12** by providing an indication of the strength of a signal being received by system **12** from an original transmitter using a multi-colored LED display will now be described. It is understood that one or more of the steps in this exemplary method may be eliminated or rearranged in various embodiments.

At step **62**, a training mode for wireless control system **12** is initiated. According to an exemplary embodiment, described above with reference to FIG. **3**, initiation of a training mode for wireless control system **12** can include continuous depression, for a pre-defined period of time such as 5 seconds, of one or more push button switches (e.g., as part of operator input device **32**) disposed on a wireless control system **12** attached to a vehicle interior element. According to alternative embodiments, initiation of the training mode can include depression of a button on a handheld wireless transmitter, such as a keyfob, use of a voice command, or any other user input to enter the training mode for wireless control system **12**.

At step **64**, control circuit **30** can turn display element **38** (e.g., an LED) associated with wireless control system **12** red to indicate to the user that the training mode for wireless control system **12** has been actuated. A red indication may further be used to indicate that no signal is currently being received by control system **12** from an original transmitter, described in further detail below. Alternatively, display element **38** may be configured to blink multiple times to indicate that training mode has been initiated but that no signal is being received and then light continuously once a signal is detected.

In a step **66**, wireless control system **12** may begin scanning for a wireless control signal being transmitted by an original transmitter for the remote electronic system **18**. According to an exemplary embodiment, a user may be instructed to actuate the original transmitter within a close range of wireless control system **12**. Accordingly, the signal being transmitted from the original transmitter will be detected and received by wireless control signal **12**.

In a step **68**, wireless control system **12** may be configured to provide an indication using the multi-colored LED display **36** of the relative strength of the received signal. The strength of the received signal may be affected be any of a variety of factors, such as the position of the original transmitter, positioning of a directional antenna in the original transmitter, objects within a transmission path between the original transmitter and control system **12**, environmental factors, etc. The stronger the signal received from the original transmitter, the more likely that control system **12** will be able to successfully train to that signal.

Signal strength may be measured by control system **12** using a received signal strength indicator (RSSI) circuit (not shown). The received signal strength may be calculated by demodulating the selected bit or bits of a frame or message modulated onto the received signal. The demodulated bit or bits may then be associated with an RF power (i.e., signal strength), and digitized with an analog-to-digital (A/D) converter. The output of the A/D converter provides the RSSI count. Received signal strength may be generated for either and/or both frequency-modulated (FM) and amplitude-modulated (AM) signals, as dictated by the received signal.

Control system **12** may be configured to use a defined color signal strength feedback scheme, previously provided to the user, to indicate the relative strength of the received signal. According to a simple example, display **36** may display a red color when the strength of the received signal

is insufficient for successful training and display a green color when the strength of the received signal is sufficient to allow training. Display **36** may further be configured to display a yellow color when the strength is intermittently strong enough although not consistent (indicating the user is close to a signal that is strong enough to train). According to another exemplary embodiment, yellow may be used to indicate that the user should move the original transmitter closer to the trainable transmitter, red may be used to indicate that the user should move it further away, and green may be used to indicate that the transmitter is in the correct position. Although a few simple examples are provided, one of ordinary skill in the art could appreciate that a variety of color schemes may be implemented.

Alternatively, advanced color signal strength feedback schemes may also be implemented. According to a first example, a color scheme may include using a combination of LED colors moving from green to orange to yellow to blue to green to indicate changes in signal strength as the user repositions the original transmitter relative to control system **12**. According to a second example, another color scheme may include alternatively flashing a red light and a green light to indicate a decrease or increase, respectively, in the received signal strength.

In a step **70**, when a signal of sufficient strength has been received, wireless control system **12** can record the signal frequency and control data to memory and generate and transmit a wireless control signal representative of the received data to actuate the remote electronic device. Where control system **12** successfully records and transmits the received signal, system **12** can turn the LED display **36** green for a period of time to indicate successful training. Following step **70**, wireless control system **12** can exit the training mode in a step **72**.

Providing a signal strength indication to a user of control system **12** can greatly facilitate training. Even where training is unsuccessful, provision of the signal strength color feedback can identify or remove signal strength as a potential source of the training issue. For example, where wireless control system **12** has provided feedback that indicates that sufficient signal strength was received during training, the user may examine other aspects of the transmission.

Referring now to FIG. **5**, an exemplary method of providing state information for wireless control system **12** using a multi-colored LED display **36** will now be described according to an exemplary embodiment. It is understood that one or more of the steps in this exemplary method may be eliminated or rearranged in various embodiments.

At step **80**, a current state of wireless control system **12** may be determined. The state of wireless control system **12** may be a representation of the functionality associated with each input switch or device **32**, shown in FIG. **2**. Accordingly, in a first state, wireless control system **12** may be configured to transmit a first wireless control signal associated with the first remote electronic system in response to actuation of a first input device and in a second state wireless control system **12** may be configured to transmit a second wireless control signal associated with a second remote electronic system in response to actuation of the same first input device. Configuring wireless control system **12** to include multiple states allows the user to control a larger number of remote electronic devices while continuing to provide a simple interface to control system **12**.

State may determined based on any of a variety of occurrences such as initiation of system **12**, such as when the user first starts the vehicle **10**, when system **12** receives a "change state" instruction, described in detail below, when system **12** resets, etc. A "change state" instruction may be received based on a user input, such as depression of one of devices **32** for a period of time or depression of multiple input devices **32**, etc. A "change state" instruction may also be generated by system **12**. For example, where system **12** is coupled to a GPS device and system **12** is able to determine that the user is traveling from a work location to a home location, system **12** may be configured to automatically change state from a work state, where input devices **32** are configured to control remote electronic systems at a work location, to a home state, where input devices **32** are configured to control remote electronic systems at a home location.

In a step **82**, wireless control system **12** may be configured to provide an indication to the user of the current state of control system **12** using the multi-colored LED display **36**. For example, display **36** be configured to be "red" in a first state, "yellow" in a second state, and "green" in a third state. Where control system **12** includes three input switches and three potential states, a user can train control system **12** to be able to transmit up to nine different wireless control signals to remote electronic system **18**. Other states may include a training mode state, an operating mode state, a transmitting state, an idle state, a button press received state (where the transmitter is configured to transmit for a period of time after the button is released), a training signal received/frequency identified/code stored/etc. state, etc.

The user may be encouraged to group remote electronic systems within each state. For example, a user may be encouraged to use a "green" state to control remote electronic systems at the user's home, a "yellow" state to control a plurality of remote electronic systems at the user's vacation property, and a "red" state to control a plurality of remote electronic systems at the user's work. Advantageously, the user will be able to recognize the current state of control system **12** and now the functionality associated with each input device **32** based on the state.

In a step **84**, following the display of the color indicia, control system **12** may be configured to reconfigure the functionality associated with each of input device **32** based on the change in state. For example, wherein a first input device was configured to control a parking garage gate and that state of control system **12** has switched from a work state to a home state, the first input device may be configured to control a garage door opener at the home of the user. After reconfiguration, control system **12** may return to a normal operating mode in a step **86** until another change of state instruction is received.

Providing a multi-colored LED indication of the current state of system **12** allows system **12** to control a larger number of remote electronic devices while maintaining the simplicity and ease of use of control system **12**. Color feedback allows the user to identify not only the current state, but also the functionality associated with each of the input devices **32**.

While the exemplary embodiments illustrated in the FIGS. and described above are presently preferred, it should be understood that these embodiments are offered by way of example only. Accordingly, the present invention is not limited to a particular embodiment, but extends to various modifications that nevertheless fall within the scope of the appended claims. The order or sequence of any process or method steps may be varied or re-sequenced according to alternative embodiments.

What is claimed is:

1. A wireless control system, for wireless control of a remote electronic system, configured to provide information to a user using a single multi-colored LED, comprising:

a trainable transmitter circuit configured to transmit a wireless control signal having control data which will control the remote electronic system;

a user interface device including one or more buttons; and

a control circuit coupled to the trainable transmitter circuit and to the user interface device, the control circuit having a plurality of states comprising a training mode state, a first operating mode state in which the wireless control system is configured to control a first remote electronic system, and a second operating mode state in which the wireless control system is configured to control a second remote electronic system;

wherein the control circuit is configured to receive a user input at a selected button of the one or more buttons,

wherein the control circuit is configured to process the user input to determine whether the user input is an instruction to cause a change between the plurality of states or an instruction to transmit a wireless control signal formatted to control a remote electronic system,

wherein in response to receiving the user input at the selected button, the control circuit is configured to cause the trainable transmitter circuit to transmit a first wireless control signal formatted to control the first remote electronic system based on a currently active state of the plurality of states being the first operating mode state and the user input being an instruction to transmit a wireless control signal,

wherein in response to receiving the user input at the same selected button, the control circuit is configured to cause the trainable transmitter circuit to transmit a second wireless control signal formatted to control the second remote electronic system based on the currently active state being the second operating mode state and the user input being an instruction to transmit a wireless control signal,

wherein in response to receiving the user input at the same selected button, the control circuit is configured to change the currently active state based on the user input being an instruction to change between the plurality of states,

wherein the control circuit is configured to control operation of the single multi-colored LED to provide an indication of the currently active state, and

wherein the control circuit is configured to cause the single multi-colored LED to change the indication in response to the user input being an instruction to change between the plurality of states.

2. The wireless control system of claim 1, further comprising a vehicle interior element coupled to the trainable transmitter circuit and the control circuit, wherein the wireless control system is configured for the mounting in a vehicle interior.

3. The wireless control system of claim 2, wherein the vehicle interior element is an overhead console, a visor, or an instrument panel.

4. The wireless control system of claim 1, further including a receiver circuit configured to receive a wireless signal, wherein the control circuit is configured to identify and store a data code on the wireless signal, and wherein the wireless control signal transmitted by the trainable transmitter circuit includes the stored data code.

5. The wireless control system of claim 1, wherein the control circuit is configured to use at least two different colors to indicate determined signal strengths that are not strong enough for use in the training mode.

6. The wireless control system of claim 1, wherein the control circuit is configured to use at least two different colors to indicate determined signal strengths that are strong enough for use in the training mode.

7. The wireless control system of claim 1, wherein the control circuit causes the multi-colored LED to indicate when a strength of a wireless control signal received from an original transmitter is sufficient for the control circuit to record a frequency and control data associated with the wireless signal to memory.

8. The wireless control system of claim 1, wherein the multi-colored LED provides feedback indicative of received signal strength during the training mode, and wherein the multi-colored LED only provides feedback indicative of received signal strength during the training mode.

9. A method of providing feedback to a user of a wireless control system for wireless control of a remote electronic system comprising:

receiving a wireless control signal as a part of a training mode of the wireless control system;

in the training mode, recording a frequency and control data associated with the wireless control signal to memory;

associating, in memory, the frequency and control data with a state of the wireless control system, the wireless control system having a plurality of states comprising the training mode, a first operating mode state in which the wireless control system is configured to control a first remote electronic system, and a second operating mode state in which the wireless control system is configured to control a second remote electronic system;

receiving a user input at a selected button of one or more buttons of a user interface device;

processing the user input to determine whether the user input is an instruction to change between the plurality of states or an instruction to transmit a wireless control signal formatted to control a remote electronic system;

in response to receiving the user input at the selected button, transmitting a first wireless control signal formatted to control the first remote electronic system based on a currently active state of the plurality of states being the first operating mode state and the user input being an instruction to transmit a wireless control signal;

in response to receiving the user input at the same selected button, transmitting a second wireless control signal formatted to control the second remote electronic system based on the currently active state being the second operating mode state and the user input being an instruction to transmit a wireless control signal;

in response to receiving the user input at the same selected button, changing the currently active state based on the user input being an instruction to change between the plurality of states; and

displaying an indication of the currently active state of the wireless control system using a multi-colored LED, wherein displaying the indication includes changing the indication based on the user input being an instruction to change between the plurality of states.

10. The method of claim 9, further including modifying a color of the multi-colored LED based upon successful training of the wireless control system to a received wireless control signal.

11. The method of claim 9, further including displaying a color at an initiation of the training mode indicative of a state of the wireless control system.

12. The method of claim 9, further including determining a signal strength of a received wireless control signal, and determining if the signal strength of the received wireless control signal is sufficient for the control circuit to record a frequency and control data associated with the wireless control signal to memory, and displaying a corresponding color indication using the multi-colored LED.

13. The method of claim 9, further comprising modifying a color of the multi-colored LED based on a signal strength of a received wireless control signal, wherein modifying the color of the multi-colored LED based on the signal strength of the received wireless control signal only occurs during the training mode.

14. The wireless control system of claim 1, wherein the control circuit is configured to reconfigure the functionality associated with the user interface device in response to a change in state and after the indication of the currently active state is provided.

15. The method of claim 9, further comprising reconfiguring the functionality associated with the user interface device in response to the change state instruction and after the indication of the currently active state is displayed.

16. The wireless control system of claim 1, wherein the control circuit is configured to control operation of the multi-colored LED to display a first color scheme in response to an increasing signal strength of a signal transmitted from a remote device to the wireless control system, and display a second color scheme in response to a decreasing signal strength of a signal transmitted from the remote device to the wireless control system.

17. The method of claim 9, further comprising modifying a displayed color scheme of the multi-colored LED to a first color scheme in response to an increase in signal strength of the received wireless control signal, and to a second color scheme in response to a decrease in signal strength of the received wireless control signal.

* * * * *